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HEAT EXCHANGER

## TECHNICAL FIELD

The present invention relates to a heat exchanger which is comprised of two or more heat exchangers having different usage.

## BACKGROUND ART

Conventional heat exchangers used for vehicles include for example a heat exchanger which is comprised of two or more heat exchangers having different operations.

For example, Japanese Patent Application Laid-Open Publication No. Hei 10-306994 discloses an invention of a heat exchanger which has a radiator core section for an engine and a condenser core section for a vehicle air conditioner configured integrally. And, Japanese Patent Application Laid-Open Publication No. Hei 10-253276 has paid attention to a ratio between a width of fins and a number of louvers, which are disposed between tubes of a condenser core section and a radiator core section, and configures so that a heat exchanger having a small required radiation amount between two integrally configured heat exchangers has a small ratio between the fin width and the number of louvers and a heat exchanger having a large required radiation amount has a ratio between the fin width and the number of louvers larger than that of the heat exchanger having the above small required radiation amount.

And, Japanese Patent Application Laid-Open Publication No. Hei 10-170184 has paid attention to the shape of louvers

formed on fins disposed between tubes of two heat exchangers, and improved the heat exchange efficiency of the two heat exchangers by configuring so that the louvers formed on the fins which are fitted to one of the heat exchangers have a shape different from louvers formed on the fins which are fitted to the other heat exchanger.

When two or more heat exchangers are disposed in parallel to a ventilating direction as in the invention described in the above publication, e.g., when the two or more heat exchangers are mounted on a vehicle, a flow of outside air is disturbed by the heat exchanger positioned on the windward side with respect to the ventilating direction. Thus, it is difficult to keep the heat-exchanging performance of the heat exchanger positioned on the leeward side.

Specifically, as shown in Fig. 4, when height  $h'c$  of tubes 13 configuring a first heat exchanger and height  $h'r$  of tubes 14 configuring a second heat exchanger are identical, a speed of air which has passed through the tubes 13 of the first heat exchanger is lowered by the presence of the tubes 13 of the first heat exchanger disposed on the windward of the ventilating direction and then the air is spread, so that the air speed is lowered along the surfaces of the tubes 14 and the portions of fins 6 in proximity to the tubes of the second heat exchanger, and the heat-exchanging performance of the second heat exchanger is significantly lowered.

To mount the heat exchangers within an engine room having a limited mounting space, the first and second heat exchangers must be mutually placed as close as possible, and they are also

demanded to be light-weighted.

Especially, when the tubes are disposed at right angles to the ventilating direction, outside air does not come into contact with the surfaces of the tubes of the second heat exchanger through which a high-temperature medium flows, so that the heat-exchanging performance is disturbed. Specially, when the tubes configuring the first and second heat exchangers have the same pitch, outside air does not flow along the surfaces of the tubes configuring the second heat exchanger, and a heat radiation amount of the second heat exchanger is lowered considerably.

Accordingly, the present invention has been completed in view of the aforesaid disadvantages, and it is an object of the invention to provide a heat exchanger which is comprised of two or more heat exchangers disposed in parallel at right angles to a ventilating direction and which can keep the heat-exchanging performance of a heat exchanger disposed on the leeward side.

#### SUMMARY OF THE INVENTION

The invention described in claim 1 of this application is a heat exchanger comprised of two or more heat exchangers which are disposed on the windward and leeward side of a ventilating direction in parallel at right angles to the ventilating direction, wherein the heat exchangers are configured by stacking a plurality of tubes; and the heights of the tubes of one heat exchanger disposed on the windward of the ventilating direction are lower than the heights of the

tubes of the other heat exchanger disposed on the leeward side.

Thus, when the two or more heat exchangers are disposed in parallel at right angles to the ventilating direction and the heights of the tubes of the heat exchanger on the windward are smaller than the heights of the tubes of the heat exchanger disposed on the leeward side, outside air which is to flow between the tubes and the fins of the heat exchangers flows along the surfaces of tubes of the heat exchanger disposed on the leeward side without being disturbed by the tubes of the heat exchanger disposed on the windward. Thus, heat is radiated from the tubes through which a high-temperature medium flows, and the heat-exchanging performance of the second heat exchanger disposed on the leeward side can be kept.

The invention described in claim 2 of the application is directed to the invention according to claim 1, wherein the respective tubes of the two or more heat exchangers disposed in parallel have approximately the same space between the stacked tubes.

For example, when the first heat exchanger and the second heat exchanger are disposed in parallel at right angles to the ventilating direction, especially when the stacked tubes configuring the first heat exchanger and the second heat exchanger have the same space between them and the same height or the heights of the tubes of the first heat exchanger is higher, the speed of the outside air having passed through the tubes of the first heat exchanger is lowered by the presence of the tubes of the first heat exchanger which is on the windward in the ventilating direction. And, the outside air having passed

through the first heat exchanger is spread and its speed is lowered on the surfaces of the tubes and the portions of the fins in proximity to the tubes of the second heat exchanger, and the heat-exchanging performance of the second heat exchanger is lowered considerably.

In this embodiment, even when the stacked tubes configuring the first and second heat exchangers have substantially the same space, the heights of the tubes configuring the first heat exchanger are lower than the heights of the tubes configuring the second heat exchanger, so that ventilation of the outside air is not disturbed, and the outside air is allowed to reach the surfaces of the tubes configuring the second heat exchanger. Thus, the heat-exchanging performance of the second heat exchanger can be kept.

The invention described in claim 3 is directed to the invention according to claim 1 or 2, wherein the respective tubes have a height of less than 1.6 mm.

The tubes configuring the heat exchanger are desired to have a height of 1.6 mm or less in view of the heat-exchanging efficiency of the heat exchanger and its weight reduction. Especially, when the first heat exchanger is a condenser, the heat-exchanging efficiency is further improved by determining the tubes to have a height of 1.3 mm or less, and it becomes possible to make the heat exchanger more compact and light-weighted.

The invention described in claim 4 is directed to the invention according to any of claims 1 to 3, wherein the two or more heat exchangers disposed in parallel have a space of

15 mm or less between them.

For example, when the first and second heat exchangers are mounted in an engine room, it is desired to mount the first and second heat exchangers, which are disposed in parallel, as close as possible to each other in order to reduce a mounting space. Meanwhile, when the first and second heat exchangers are disposed adjacent to each other, the outside air flowing to the second heat exchanger is disturbed by the first heat exchanger disposed on the windward in the ventilating direction, and the heat-exchanging performance of the heat exchanger disposed on the leeward side in the ventilating direction cannot be kept.

It is determined by the present invention that the heights of the tubes configuring the heat exchanger disposed on the windward are smaller than the heights of the tubes configuring the heat exchanger disposed on the leeward side. Therefore, the heat-exchanging performance of the second heat exchanger can be kept even if the first and second heat exchangers are disposed closely to have a space of 15 mm between them.

The invention described in claim 5 is directed to the invention according to any of claims 1 to 4, wherein one of the heat exchangers is a condenser and the other is a radiator.

In other words, the heat exchangers to be mounted closely to each other in the engine room are often comprised of the condenser configuring a heat exchange cycle for air conditioning and the radiator for cooling an engine, which are required to have high heat-exchanging performance.

The invention described in claim 6 is directed to the

invention according to any of claims 1 to 5, wherein the two or more heat exchangers are integrally configured using a common member.

When the two or more heat exchangers are integrally configured by a common member, for example, a bracket, the heat exchangers are light-weighted, and their mounting in the engine room or the like is facilitated without increasing the mounting space.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view schematically showing the structure of first and second heat exchangers according to an embodiment of the present invention;

Fig. 2 is a partially sectional view of the heat exchangers of Fig. 1 according to the embodiment of the invention;

Fig. 3 is a diagram showing a relation between a ratio of the heights of tubes configuring the first and second heat exchangers and a ratio of a heat radiation amount of the second heat exchanger according to the embodiment of the invention; and

Fig. 4 is a partially sectional view of first and second heat exchangers according to prior art.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 is a perspective view schematically showing the structure of this embodiment.

As shown in Fig. 1, the heat exchanger of this embodiment

has first and second heat exchangers 1, 2 which are disposed in parallel with respect to a ventilating direction.

The individual heat exchangers 1, 2 have a plurality of tubes 3, 4 and fins 5, 6 fitted between the tubes 3, 4 to increase a radiation area. The tubes 3, 4 and the fins 5, 6 are stacked into a plurality of layers, and each end of the tubes 3, 4 is connected to header tanks 7, 8, 9, 10. A heat-exchanging medium is distributed to flow from the respective header tanks 7, 8 to the individual tubes 3, 4 to perform heat exchange so that the high-temperature medium becomes a low-temperature medium by radiation from the tubes 3, 4 and the fins 5, 6.

An arrow in Fig. 1 indicates a ventilating direction of outside air.

The first and second heat exchangers 1, 2 of this embodiment are supported and integrally configured by common members. In this embodiment, brackets 15 are used to fix the first and second heat exchangers 1, 2 with bolts. Specifically, two brackets 15 each are disposed on the top and bottom of end plates of both heat exchangers, and a bolt is inserted for fixing through each bracket in the longitudinal direction of a vehicle. Thus, when the first and second heat exchangers are integrally configured by the common members, the brackets which have been separately fitted to the respective heat exchangers can be eliminated by virtue of the common member. Thus, the heat exchangers can be light-weighted and mounted in an engine room with ease.

In this embodiment, a condenser for a vehicle air conditioner which is the first heat exchanger 1 is disposed on

the windward of the ventilating direction, and an engine radiator which is the second heat exchanger 2 is disposed on the leeward side of the ventilating direction.

The heat exchangers 1, 2 of this embodiment have a space K of 15 mm between the condenser as the first heat exchanger 1 and the radiator as the second heat exchanger 2 in order to reduce a mounting space. Especially, it is significant to reduce the mounting space in order to mount the heat exchangers on a vehicle.

Thus, when the first heat exchanger 1 and the second heat exchanger 2 are closely mounted to each other, ventilation of outside air is disturbed by the first heat exchanger 1 which is disposed on the windward of the ventilating direction, and the outside air does not flow through the second heat exchanger 2, particularly along the surfaces of the tubes 4 through which the medium flows. Thus, a desired heat-exchanging performance cannot be obtained.

Therefore, in this embodiment, height  $h_c$  of the tubes configuring the first heat exchanger 1 which is disposed in parallel to the second heat exchanger and at right angles to the ventilating direction is determined to be smaller than height  $h_r$  of the tubes configuring the second heat exchanger 2.

In other words, the heights of the tubes configuring the first and second heat exchangers which are disposed in parallel at right angles to the ventilating direction have a relation of  $h_c < h_r$ .

Fig. 2 is a partially sectional view of the first and

second heat exchangers 1, 2, showing the tubes 3, 4 and the fins 5, 6. In Fig. 2, reference numerals 11, 12 indicate louvers formed on the fins 5, 6. The arrows in the drawing indicate the ventilating direction of outside air.

Fig. 3 is a diagram showing a relation between a ratio of the heights of the tubes configuring the first and second heat exchangers and a heat radiation amount of the second heat exchanger.

As shown in Fig. 3, the ratio of the heat radiation amount of the second heat exchanger is improved when  $hr/hc > 1$  or more, namely when the heights of the tubes of the condenser disposed on the windward of the ventilating direction are smaller than the heights of the tubes of the radiator disposed on the leeward side of the ventilating direction.

In Fig. 3, a point B indicates that a relation between the height  $h'c$  of the tubes of the first heat exchanger and the height  $h'r$  of the tubes of the second heat exchanger is  $h'c = h'r$ .

A Point A in Fig. 3 indicates that a relation between the heights of the tubes 3, 4 of the first and second heat exchangers is  $hr/hc > 1$  shown in this embodiment.

A Point C in Fig. 3 indicates that a relation between the heights  $hr$  and  $hc$  of the tubes of the first and second heat exchangers is  $hr/hc < 1$ .

The tubes 3, 4 configuring the heat exchangers 1, 2 are desired to have a height of less than 1.6 mm considering the heat-exchanging performance and weight reduction of the heat exchangers. Particularly, when the first heat exchanger is a

condenser as in this embodiment, the heat-exchanging efficiency is improved furthermore by determining the tubes to have a height of 1.3 mm or less. And, the heat exchanger can be made more compact and light-weighted.

Accordingly, the tubes 3, 4 of the heat exchangers 1, 2 are formed in this embodiment basically to satisfy the relation of  $hc < hr < 1.6$  mm.

By forming the first and second heat exchangers using the tubes meeting the above inequality, the heat-exchanging performance of the second heat exchanger can be improved better than before without increasing the mounting space.

The condenser used for a heat-exchanging cycle of a car air conditioner and the radiator for cooling an engine are disposed in an engine room in parallel at right angles to the ventilating direction.

When the tubes of the condenser as the first heat exchanger are configured to have a height smaller than the heights of the tubes of the radiator as the second heat exchanger as in this embodiment, the heat-exchanging performance of the second heat exchanger is not disturbed by the first heat exchanger, and the required high heat-exchanging performance can be obtained.

#### INDUSTRIAL APPLICABILITY

The heat exchanger according to the present invention, which is comprised of two or more heat exchangers disposed in parallel on the windward and leeward in the ventilating direction, can improve the heat-exchanging performance of the